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SCIENCE

FRIDAY, MAY 4, 1917

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SOME OF THE SCIENTIFIC PROBLEMS AND DUTIES AT OUR DOORS[1]

WE are here at the second meeting of a new endeavor on the part of the American Association to foster an interest in scientific work and in scientific research, and it is sincerely hoped that we shall worthily do for and in this portion of our country what the parent association has done for the country at large, and what the British Association has so long been doing for Great Britain. It is for us not only to keep alive the interest in the good work of the general organization, but to widen its scope, to extend its influence and to bring it to a higher degree of usefulness.

Our national association has been a power for good in this country from its inception in 1848, for it has helped to awaken and has kept alive a widespread interest in science throughout our country, and it has brought together and kept in touch with each other persons interested in the various branches of science.

Since 1831 the British Association for the Advancement of Science has been a powerful and even a remarkable agency in the encouragement of local workers in Great Britain, and in the quickening of interest in every branch of science. But while the British Association has of late years visited Australia, Canada and South Africa, from the outset most of its activities have been confined to England, Wales, Scotland and Ireland, an area (121,112 sq. ms.) smaller than that of the state of

[1] Presidential address before the Pacific Division of the American Association for the Advancement of Science, at Stanford University, California, April 5, 1917.

California alone (158,360 sq. ms.), and having a population of forty-five millions as compared with California's one and a half millions at about the same period. But when we consider that we are expected to hatch out the eggs of science over the area extending from the Rocky Mountains to the Philippine Islands, and from the polar regions in northern Alaska to the torrid zone, we must realize that we have entered upon no trifling undertaking.

These facts are mentioned in order that we may not have false ideas of the relations of our population to the area of our operations—a factor in the problem that can not be overlooked. In a denser population where interest in any one subject has a large following it is comparatively easy to keep that interest alive and active. With our smaller population scattered over a vast area, and that population but indifferently provided with educational facilities, we must expect to meet obstacles that are inseparable from a country as new as this of ours, and to find it necessary to make extraordinary efforts if we would look forward to extraordinary results.

Many of the people about us here on the Pacific coast are quite as well prepared to do scientific work as any in the world, but we can not shut our eyes to the fact that the great bulk of our population are engaged in the work of pioneers whether they live in cities, villages, on farms, in the forests, or in the mines. Our educational institutions are manned by as able scholars as can be found anywhere, but the number of such scholars is small, while the library and laboratory equipments at their service are more or less defective. We must huddle together, as it were, to keep warm and to keep up our courage.

But even if we are still living in the pioneer days of science on this coast, we have the rewards of pioneers for whatever we may do: we live in the open, we have a certain independence that is worth much to the student of science in the way of encouragement of originality, while the fact that we are thrown on our own resources in many respects has decided advantages for young workers, and even for the older ones.

Our Duty to the Public.—We may well ask ourselves what duties devolve upon us as live and active members of this lately formed organization of scientific men with its center of activities right here about the Bay of San Francisco. My experience with the work of the American Association and with the British Association cover a period of thirty-five years, so that in making a few suggestions in regard to what seems to be the legitimate scope of our future operations, I shall not be drawing entirely upon my imagination.

The benefits to be derived from such an organization are, or should be, vastly more than what is to be expected from the simple conferring together of those who are interested in similar kinds of scientific work.

What of our relations to the public? In my opinion we have no more serious duties than to have and to cultivate a broad and intelligent interest in science as it is related to society at large. If we do not have such an interest we fail in one of our most obvious opportunities as men of science and as public-spirited citizens.

Scientific questions often arise in the discharge of the duties of our public executive officers. Our presidents, governors, judges, mayors and others in public office need the services of men of science, while legislators who have to legislate upon matters that involve scientific problems are equally in need of the advice of competent and unbiased men. It is clearly our duty to place our knowledge, our training, and our best judgment at the service of such men, and thus at the service of the public,

and to stand together in whatever is right in connection with matters relating to or involving a knowledge of science.

Legislation.—In any and every state a glance at a list of the bills introduced in the legislature can not fail to impress us with the need and the importance of a knowledge of various branches of science on the part of our legislative and executive officers. Legislative support for our scientific bureaus and for higher education must come from the backing given them either directly or indirectly by men of science. But when executive and legislative officers are chosen as ours are it would be a mere accident if they had the special knowledge necessary to legislate about matters that require such knowledge. Indeed it not infrequently happens that our public officials have their judgment biased by hearsay information and prejudices that are difficult to deal with.

Take as an example the case of legislation upon vivisection that has lately been up right here in our own state. We are impelled to ask what is to be expected from legislation on such a subject unless the men of science in the state make themselves heard and felt. Not that most of us really know anything about vivisection; we do not. But we do know what scientific methods are and where they lead, and as men of science we are bound to use our influence in support of such methods. Physiologists—not sentimentalists—are the ones to determine whether or not vivisection should or should not be allowed, and our voices should be heard in support of the physiologists and in favor of right methods in that as in anything else.

The new kelp industry of our coast already has problems in our state legislature. Surely the questions involved in this and in all similar cases should not be left to haphazard legislation dictated by selfish interests of any kind whatever, but should be settled by scientific men as scientific problems that concern the community at large.

I might well add the importance of scientific knowledge in the drafting and passing of fish and game laws, laws relating to the seal fisheries, to insect pests, to smelter fumes, to the conservation of timber, and to rational methods of mining and the conservation of our mineral resources, all of them problems closely related to our industries and to our future.

I have heard it objected that we have no call to offer our advice where it is not sought. This raises a point in ethics which puzzles some persons unnecessarily. We have also heard of a person who would not rescue a drowning man because he had not been introduced to him. We do not hesitate to cast our ballots and to lift our voices in favor of what we regard as right methods in public affairs. Nor should we hesitate to do any other act that we know to be for the public good, whether that act be formally called for or not.

I merely mention these instances in passing and as examples of some of the public duties of scientific men which we too often overlook. Such problems confront men of science everywhere, and it is to be hoped that we shall not evade them in this the newer part of our country.

SCIENTIFIC PROBLEMS

If I were asked by this association to suggest problems that the scientific world has a right to expect us to solve, or at least to attack seriously, it would bring to mind first of all the most scathing criticism I ever heard of any scientific man—a criticism made on the ground that he had spent a lifetime in a certain field where he had a unique opportunity for solving certain problems that he never solved, and that he

never made any serious effort to solve. Evidently the man had no powers of imagination, and no comprehension of the importance or bearing of the problems under his feet, and he seemed to stare and blink at them like a dazed owl. What little he did lacked purpose enough to keep him awake and at work, while ordinary professional courtesy prevented others from going into the field that accident had placed in his incompetent hands. And what has that to do with us?

One's life as a scientific man is like his life as an individual in this, that he has the hope of rounding it out satisfactorily and of leaving his work well and conscientiously done. We can not conceive, therefore, of anything more humiliating to us in our professional capacities than a failure to attack the problems that nature or opportunity has placed under our hands.

I can imagine some one objecting to local problems as not being big enough for full-grown men. It is true that the laws of science are world-wide, they are even as wide as the universe itself. None the less some of these problems have been solved right here on this humble little earth of ours, and, if we are big enough, we may yet solve more of them right here in the state of California.

Some problems are necessarily localized; and nowadays when one wants to study a thing he goes where the thing is. And that is just another way of saying that laboratory work is best done in a laboratory, while field work is best done in the field where one can see his materials in abundance.

What have we here that they have not everywhere else in the world? What local problems have we that are well worthy of our attention and of our best efforts? I can only mention two or three of them, and these must be accepted simply as examples.

Chemistry.—For the chemists we have one of the great oil, gas and asphaltum regions of the world with all of the complex problems connected with the origin of petroleum and with the vast number of products derived and derivable from it.

We have here too a great number of lakes of concentrated waters: soda lakes, borax lakes, and salt lakes, with an infinite number of interesting problems that call for solution, and offer substantial rewards for it.

The availability of a cheap and abundant supply of electricity affords unusual opportunities for studying and investigating electro-chemical subjects.

In the presence of these subjects and opportunities the chemists seem to stand on the shores of a vast and uncharted ocean that they hardly dare embark upon.

Tropical Diseases.—The territory allotted to the Pacific Division of the American Association includes large areas in the tropics—Mexico and the Sandwich Islands, and the Philippine Islands. These facts, and the opening of the Panama Canal and the growth of trade, and the development of commercial intercourse between our western ports and tropical countries, and especially between us and Asiatic countries, ought to impress us with the importance of our study of tropical diseases. Soon or late we shall have to deal with such diseases, and unless we undertake the work promptly and with thoroughness we shall pay dearly for it later on. If we are not willing to do this from our interest in science, we shall have to do it as a matter of self-protection. The port of San Francisco is close to every town on this coast, and it is at San Francisco that tropical diseases are most likely to land.

Geology.—As I have said, these cases are cited merely as examples, for I find that there is hardly a branch of science that has not here, within our province, an em-

barrassment of riches well worthy of the best efforts of our best men. I therefore pass over most of these subjects and come to geology, with the problems of which I am more familiar. And if I speak of them more at length, it is because of that familiarity, and not because I regard them as of more importance than those of other branches of science. But even in speaking of geology, whose local problems are remarkably numerous and important, I am obliged to confine myself to a single topic.

We have in geology an excellent illustration of the importance and of the splendid results to be expected in attacking some of the problems under our hands. The fossil vertebrates found in the asphaltum deposits near Los Angeles have been promptly and thoroughly looked after by our colleague Dr. Merriam, of the University of California, with results that have not been surpassed by any work of the kind done in any other quarter of the globe. How fortunate for us and for science that Dr. J. C. Merriam did not think a local problem unworthy of his attention.

Earthquakes.—But I regret to say that we also have here a geological problem of another kind. I hesitate even to mention it, perhaps because an old Spanish proverb says that "in the house of a hangman one should never mention rope." And in California one has to take his courage in both hands when he says "earthquake."

Here is a problem, or rather a great group of problems, that nature has left on our very doorsteps. What are we doing with it, and what do we propose to do?

The earthquake of 1906 jolted us into a state of temporary wakefulness, but we seem calmly to have gone asleep again. The only thing to our credit in connection with it is the excellent report of Dr. A. C. Lawson, which stands out, and stands alone, as a contribution to seismology in this country. Very largely through the impetus given to the study of seismology by the earthquake of 1906, the Seismological Society of America was formed here in California in the hope that we might get the cordial support of scientific men and of public-spirited people generally in the study of earthquakes.

Through the patient exertions and personal sacrifices of a handful of men and through the generous contribution of our colleague Mr. Robert W. Sayles, of Harvard University, we have been able to publish six volumes of the society's quarterly bulletin and to get started on a road that seems to lead somewhere.

I am merely stating a fact in connection with this subject when I say that instead of taking hold of the problems of the earthquakes, most of us seem disposed to run from them; or what is still worse, we deny their very existence, while the cooperation and help we hoped to receive from the public has not been forthcoming. Certain branches of business are especially liable to damage from earthquakes, and it seems quite reasonable that such industries should cooperate with us by gathering and sending in data regarding earthquakes as they occur. Our railway lines, with their many bridges, cuts and fills, are liable to be seriously damaged and their service interrupted, to say nothing of the possible danger to human life through trains running into dislocations; our telegraph and telephone lines are liable to be broken and their service interrupted; our electric power companies are liable to have their dams injured, their pipe lines and wires broken, and their service seriously interfered with; our water companies are liable to have their dams injured or destroyed, their water mains broken and their service impaired; while our insurance companies are perplexed by rate problems in a region

where, in order to protect themselves, they are compelled to make their customers pay for risks about which we are all equally ignorant. As a matter of fact not a single railway or tramway company, not a single telegraph or telephone company, not a single insurance company, not a single electric power company, and only one water company—the Spring Valley Water Company of San Francisco—has ever manifested the slightest interest in our work or lifted a finger to help us gather the data necessary for a rational study of the earthquake problems of this coast. What could we not do if we had the cordial cooperation of all such organizations on this coast? It seems almost incredible that the business interests of this state and of this coast should willingly and weakly, year after year, allow a permanent threat to hang over their industries, their transportation lines, their public utilities, and their very existence, without making an intelligent effort to study the subject or to help those who are willing and anxious to study it, and to find means of meeting it. Yet such are the sad facts.

What is the explanation of this remarkable state of affairs? So far as I am able to judge, it comes from the false attitude into which the people of this coast have unwittingly drifted. At the time of the earliest settlement of the Pacific coast by whites, pious people grouped the earthquakes along with a choice lot of other disasters and calamities commonly known as "acts of God." And naturally enough pious people regarded the acts of God as things to which we should take off our hats, but which should not be questioned or irreverently pried into.

In time they came to be simply accepted as drawbacks to the general attractiveness of California, and as such it seemed best to regard them as evils to be endured but not to be talked about. Here was a great and beautiful land that lacked capital, a good class of immigrants, and the development of its natural resources; and nothing must be said or done to frighten away either the capital or the immigrants. If the news of an earthquake occasionally made its way out of the state it was immediately given a back seat by being confronted with the enormous damage done by destructive tornadoes and annual floods in the Mississippi Valley. Our real-estate agents rarely or never heard of earthquakes; it seemed better that they should not; such things interfered with business. About the same time the newspapers fell into the habit of forgetting to mention them, and there seemed to grow up spontaneously a sort of conspiracy of silence in regard to the subject. And so it came about that when the earthquake of 1906 broke the water mains of the Spring Valley Water Company and at the same moment set fire to the city of San Francisco, we were entangled in the snares of our own weaving. And now see how we tried to hide our heads in the sand. The geologists hereabout were very anxious to gather the data made available by that particular earthquake, but as the necessary field work required considerable funds efforts were made to interest some of our business men in the subject. But our business men rose up almost to a man and assured us in the most emphatic language that there had been no earthquake, and we were told to "forget it"; to "cut it out," and above all, to publish no report on it.

It is not necessary to tell this audience that such an attitude is false and absolutely untenable. The battles of science can not be successfully fought with the weapons of ignorance and bigotry.

I am confident that this state of affairs can not long endure. Very likely indeed we have not done our own duty in pointing

out what seems to be a rational method in handling the whole matter. But a rational method demands first of all that we face about and get on the right road.

Science knows but one way to deal with its problems, and that is to face them in the open; that is the doctrine to be preached, and to be practised, and it is the only one.

The more I study earthquakes the more I am convinced that their dangers have been greatly exaggerated by our ignorance and through our efforts to cover them up; and the more am I convinced that a systematic study of the subject on this coast will yet enable us to outline with reasonable precision the areas in which they are liable to be severe, and in this way we may yet do away with their greatest dangers. Such work should eventually enable us to locate dams, bridges and buildings with reference to earthquake risks, and it should enable the insurance companies to deal justly with their customers, and, at the same time, to protect their own legitimate interests.

But such work can not be done in a month or a year, nor yet in ten years. Neither can we depend on the stimulation of violent earthquakes to keep people alive to its importance. Indeed, very little is to be expected of people who require violent stimulants to keep them going. Machinery of that kind generally stops when the stimulants give out. Those who enter this field should be people of some steadfastness of purpose, and who have little or no ambition to pose or dance in the limelights.

It will require years of careful collaboration, of patient gathering of data, of careful study, the mapping of the areas in which the shocks are felt, and the study of the geology in order to know just what is going on, and what is likely to happen.

To those who may think favorably of helping us in our efforts to study earthquakes I should speak this word of warning: Don't expect too much of us, and don't expect it too soon. Science must go its own gait, in its own way, and it often finds itself in a blind alley. It is trying; we wish it were otherwise; but it can not be helped. We can not trust the methods, dogmas or conclusions of authority in science.

Science bows down to truth and to truth alone; we have no apologies to make for its methods, its processes or its conclusions. The more we know about the complications and apparent contradictions of absolute truth, the more we distrust the cocksure and the authoritative settlement of scientific problems. To many minds authority points out the only satisfactory way and not only insists upon it, but cites volume, chapter and page to prove it, while science hesitates, vacillates, theorizes, and, brazenly or weakly, confesses its ignorance. There is no doubt about which one of those guides the crowd will follow, but neither is there any doubt about where a crowd, so led, must finally come out. Eça de Queroz quotes a learned writer as stating that "Adam, the father of men, was created October 28th at two o'clock in the afternoon." Here speaks authority, and we must confess that it offers us a clean-cut starting point for the human race that does away at a single stroke with the doubts and hesitations of modern science.

Compare this with the confession of a modern, conscientious physician who is called to attend a sick child. He asks a great many questions, he takes temperatures, and he does everything he can to discover the nature of the illness, and finally when asked point blank what ails the child, he replies: "Mrs. Blank, I'll be doggoned if I know what the matter is with the baby."

People who depend on hocus-pocus, and are on the lookout for the psychology of the

case would probably say that such an admission is a psychological error, but I am sure that it warms the heart of every scientific man to find a man who has the courage to tell the unvarnished truth, however much he may regret the necessity of it. And we shall have to follow this course and no other in dealing with earthquakes. In this spirit we need the cooperation and support of all men of science, and we feel that we are justly entitled to such support. We also need the support of business men, and we feel that we are equally entitled to it.

Very likely some of you may feel that you do not like to have this or any of these local problems flung at your heads in this brusque fashion. But, my friends, nature has already flung these problems, not only at our heads, but in our very faces. Is it not for us to wake up and be equal to our opportunities? Unless we take hold of the problems of seismology that are so conspicuously our problems here on this coast we shall stand justly discredited in the minds of our colleagues in other parts of the world. The Portuguese have a proverb about people who "fetch water after the house is burned up." Let us see if we can't fetch the water in season.

And while I am using plain language about disagreeable things, I may as well refer to one more unpleasant subject, and have done with it, and that is the necessity of financial backing. Men of science can do the work of science, but they can not foot the bills. For that part of this undertaking we must look to business men. And we look to them with confidence that they will cheerfully do their part. And if we will all pull together and keep up our courage, I feel confident that the day will come when earthquakes will have lost most of their terrors, not only for us on this coast, but for the human race.

Let me end with the words of a California author (Edward Rowland Sill) on opportunity:

OPPORTUNITY

This I beheld, or dreamed it in a dream:
There spread a cloud of dust along a plain;
And underneath the cloud, or in it, raged
A furious battle, and men yelled, and swords
Shocked upon swords and shields. A prince's banner
Wavered, then staggered backward, hemmed by foes.
A craven hung along the battle's edge,
And thought, "Had I a sword of keener steel—
That blue blade that the king's son bears,—but this
Blunt thing—!" he snapt and flung it from his hand,
And lowering crept away and left the field.
Then came the king's son, wounded, sore bestead,
And weaponless, and saw the broken sword,
Hilt-buried in the dry and trodden sand,
And ran and snatched it, and with battle-shout
Lifted afresh he hewed his enemy down,
And saved a great cause that heroic day.

John Casper Branner
Stanford University

SCIENTIFIC EVENTS

THE USE OF PRIMITIVE ART IN TEXTILES

In answer to the demand of the American textile industry for designs inspired by the primitive art of this continent, the American Museum of Natural History of New York City on April 16 sent Dr. Herbert J. Spinden, of its department of anthropology, to make special researches in Central American countries. His mission is a development of the policy of the institution to exert a formative influence on modern industry. The European War placed manufacturers of textiles largely on their own resources, as far as designs were concerned. Previously they had been guided largely by the traditions and example of Paris. The museum, recognizing this condition, placed all of its resources and research material at the command of the American looms, and its collections were studied by designers from all parts of the United States. The recent exhibition of figured textiles in the museum conveys an idea of the success which has attended the intro-

duction of the primitive art motif into modern designing.

Dr. Spinden will begin forwarding specimens to New York as soon after his arrival in the field as possible. He will start in Guatemala and extend his investigations to western Honduras, Salvador and Nicaragua. In these localities are small groups of Indians most interesting for their civilization and culture, although comparatively little known. Dr. Spinden will not only obtain examples of designs but will also learn the details of the art of weaving and study the dyestuffs used by the native artisans. The costumes worn by the Indians of Central American countries are not only picturesque, but have many details of construction which might be successfully adapted. The fundamental ideas on which these garments are based are said to be unique.

Dr. Spinden will also get all possible information concerning the native food products with a view to calling attention to their economic value, which is often very great. Specimens of these alimentary substances will be collected for display in the Preparedness Exhibit which the American Museum now has under way. Dr. Spinden will be accompanied by S. G. Morley, of the Carnegie Institution of Washington, who is likewise interested in the archeological features of the expedition. The work is undertaken with the official sanction of all the Central American governments. Most of the traveling will be on mule back through mountainous and sparsely settled regions and over native trails. Dr. Spinden left New York on April 16 and expects to return in about three months.

RESEARCH WORK OF THE LEANDER McCORMICK OBSERVATORY

THE visiting committee of the Leander McCormick Observatory of the University of Virginia met in Washington on April 17. The director reported that the scientific work accomplished during the year was as follows:

1. The determination of the parallax of fifty stars, results thus having been obtained on one hundred and twenty-five stars since the parallax work was started two and a half years ago. A preliminary value of the parallax of Barnard's star of large proper motion was found to be 0″.47.

2. More than 10,000 observations of meteors were made by amateurs during the year 1916, and were sent in to the McCormick Observatory for discussion and publication. This probably makes the largest number of meteor observations ever collected in any one year, except perhaps during the years of a meteor shower.

3. A plan of cooperation has been entered into with Harvard College Observatory whereby the 26-inch refractor is to be used for the visual observation of variable stars while they are at minima. More than one hundred and fifty stars are on the program, these stars being mainly long period variables.

4. Photographs have been made with an objective grating and with yellow light in order to find the photovisual magnitudes of the Harvard Standard regions.

5. Micrometric measures by C. P. Olivier of two hundred double stars have been published in the *Astronomical Journal*.

Grateful acknowledgment was expressed for financial assistance from the Leander McCormick estate, from the special Adams fellowship from Columbia University for parallax work, from the J. Lawrence Smith fund of the National Academy of Sciences for research on meteors, and for the gift of a wireless apparatus and a computing machine from Mr. John Neilson, of New York.

THE ENGINEERING COMMITTEE OF THE NATIONAL RESEARCH COUNCIL

THE following engineering committee has been appointed: George F. Swain and Edgar C. Marburg (representing American Society of Civil Engineers), Pope Yeatman and Albert Sauveur (representing American Institute of Mining Engineers), C. D. Young and William F. Durand (representing American Society of Mechanical Engineers), Frank B. Jewett and Clayton H. Sharp (representing American Institute of Electrical Engineers), Lewis B. Stillwell (representing American Institute of Consulting Engineers), John A. Brashear, George K. Burgess, J. J. Carty, Howard E. Coffin, John R. Freeman, Hollis Godfrey,

W. F. M. Goss, Clemens Hershel, M. I. Pupin, Charles F. Rand, C. E. Skinner, S. W. Stratton, Ambrose Swasey, Elihu Thomson.

Previous to the appointment of this committee the following letter, dated April 18, 1917, was addressed to the presidents of the American Societies of Civil, Electrical, Mechanical and Mining Engineers:

The National Research Council desires to increase its means of serving the government in support of National Defense by enlisting through an engineering committee the services of a group of distinguished engineers drawn from the field of engineering research in each of the four main divisions of civil, mining, mechanical and electrical engineering.

The members of this committee would deal directly with engineering research problems falling within the spheres of their experience, and would serve as representatives of their respective national engineering societies for the calling upon other members of those societies for the services which the societies have offered to the government in connection with problems of defense and other problems that have been referred to the National Research Council.

The National Research Council operates through a number of central committees covering the physical sciences, medicine, hygiene, agriculture and other subjects as described in the pamphlet, enclosed herewith, which gives the scheme of organization of the council as developed up to January 15, 1917.

The engineering committee is a central committee coordinate with the other central committees therein listed.

In addition to services in the field of engineering research the council has need of some general engineering services auxiliary to problems of research, and desires to be in a position to enlist such services in support of the general objects of the council.

These objects are, to bring into cooperation existing governmental, educational, industrial and other research organizations with the purpose of encouraging the investigation of natural phenomena, the increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare.

The relation of the National Research Council to The Engineering Foundation is described in enclosed report by the secretary of The Engineering Foundation.

The relation of the National Research Council to the Council of National Defense is indicated by the following resolution, passed on the 21st of February, by the Council of National Defense:

Resolved, that the Council of National Defense, recognizing that the National Research Council, at the request of the President of the United States has organized the scientific forces of the country in the interest of National Defense and National welfare, requests that the National Research Council cooperate with it in matters pertaining to scientific research for National Defense and to this end the Council of National Defense suggests that the National Research Council appoint a committee of not more than three, at least one of whom shall be located in Washington, for the purpose of maintaining active relations with the director of the Council of National Defense.

The executive committee of the National Research Council would appreciate it if on behalf of the American Institute of Electrical Engineers you would designate two engineers skilled in engineering research, whom the committee may appoint members of the engineering committee of the National Research Council, to render the services outlined in this communication and to serve as a means of calling upon other members of the American Institute of Electrical Engineers for services that the National Research Council may need in support of the national objects herein referred to.

George E. Hale,
Chairman, National Research Council,
John J. Carty,
Chairman, Executive Committee,
Gano Dunn,
Chairman, Engineering Committee

MEDICAL STUDENTS AND THE WAR

The Medical School Committee of the Medical Board of the Council of National Defense has made the following report:

In your effort to solve the urgent problem before this board and assist the surgeon general in supplying an adequate number of medical officers for the Army and Navy, it is important that this country should not repeat England's blunder at the outbreak of the war in permitting the disorganization of the medical schools either by calling the faculties into active service or sanctioning the enlistment of medical students into any of the line organizations. Ordinary foresight demands that we face the possibility that the war upon which we

have entered may last for years. Medical schools to supply trained men for the future as well as the present emergency must be kept in active operation under any circumstances. While aiding to the uttermost in overcoming the present shortage of men, the necessity of keeping the source of supply open emphasizes the importance of conserving our raw material. Therefore, men now in college looking forward to medicine as a career should be made to understand that it is their patriotic duty to the nation at this time to continue their studies and enroll in the medical school of their choice. Furthermore, no medical student who has not completed three years of medical work should be permitted to give up his course, as the country needs his trained and not his untrained service.

There are, however, ways in which the medical schools can help the present situation. The following suggestions are made for your consideration and action:

1. Medical schools should be prepared to graduate senior medical students promptly in case of need. The faculties should urge all graduates who can be relieved of their obligations as internes in civil hospitals to enroll in the medical corps of the Army and Navy.

2. Medical schools should be encouraged to consider as a form of service, the Italian plan by which base hospital units can be organized through the Red Cross. These military hospitals carry with them the clinical faculty and students as medical personnel. This type of organization meets two ends—practical help can be rendered to the Army or the Navy in time of war and instruction may be continued at the base. This permits the graduation of men directly into the junior grades of the Army after the most practical form of military instruction.

3. Fourth-year students may be allowed to substitute, in special cases, service in a base hospital for the fourth year in the hospital at home when opportunities are offered for instruction in such military institutions.

4. Medical schools that do not adopt the Italian plan should be prepared to reduce the faculties to the minimum required for routine work and enroll all men so liberated in the Medical Officers Reserve Corps.

To put these recommendations into immediate effect, the committee suggested that the Council of National Defense send a telegram to the deans of all medical schools, urging that all medical students until the fourth year is reached should be discouraged from enlisting at present in any line or sanitary organization; and another telegram to the presidents of all colleges and universities saying that national safety demands that all undergraduates planning to study medicine should enroll in the medical school of their choice at the earliest possible moment.

SCIENTIFIC NOTES AND NEWS

THE following have been elected to membership in the American Philosophical Society: *Residents of the United States:* William Frederick Durand, Ph.D., Stanford University, Calif.; Pierre Samuel duPont, Mendenhall, Pa.; Carl H. Eigenmann, Ph.D., Bloomington, Ind.; Charles Holmes Herty, Ph.D., New York; Herbert E. Ives, Ph.D., Philadelphia; Waldemar Lindgren, Ph.D., Sc.D., Cambridge, Mass.; Walton Brooks McDaniel, Ph.D., Philadelphia; Winthrop J. V. Osterhout, Ph.D., Cambridge, Mass.; Harold Pender, Ph.D., Philadelphia; Frederick Hanley Seares, B.S., Pasadena, Calif.; George Owen Squier, Ph.D., Washington, D. C.; Charles P. Steinmetz, Ph.D., Schenectady, N. Y.; Oscar S. Straus, LL.D., New York City; Alonzo Englebert Taylor, M.D., Philadelphia; Edwin Bidwell Wilson, Ph.D., Cambridge, Mass. *Foreign Residents:* Archibald Byron Macallum, F.R.S., Toronto; Sir David Prain, F.R.S., Kew.

SIR ERNEST SHACKLETON has been elected to the honorary fellowship of the American Museum of Natural History, the highest scientific honor which the institution has to bestow. This is in recognition of his Antarctic explorations and his heroic efforts in rescuing the members of his party. Sir Ernest becomes the ninth honorary fellow of the American Museum, the others being: Roald Amundsen, Dr. Bashford Dean, Lieutenant George T. Emmons, U. S. N., Geo. Bird Grinnell, Baron Ludovic Moncheur, Rear Admiral Robert E. Peary, U. S. N., Dr. Leonard C. Sanford and Vilhjamur Stefansson.

THE faculty of Wellesley College has awarded the Alice Freeman Palmer Fellowship for the year 1917–18 to Miss Hilda Hempl, A.B. (Stanford, '14), M.S. (Michigan, '15). Miss Hempl has been studying at the Serum

Institute in Copenhagen, the Lister Institute for Preventive Medicine in London, the Pasteur Institute in Paris, and is now at the Pasteur Institute in Algiers. Under appointment as Alice Freeman Palmer Fellow she will continue work in connection with the study of anaërobic wound infection and tropic diseases.

The board of trustees of the University of Maine has established the following committees at the suggestion of the National Research Council: *From the Faculty:* J. S. Stevens, Raymond Pearl, C. D. Woods, M. A. Chrysler and C. B. Brown. *Representing the Alumni:* W. H. Jordan, G. P. Merrill, Allen Rogers, L. R. Cary and H. W. Bearce. *Representing the Trustees:* S. W. Gould, W. H. Looney and F. H. Strickland.

The following resignations from the medical faculty and the instructing staff of the college of physicians and surgeons have been accepted by the trustees of Columbia University: Dr. George E. Brewer, as professor of surgery; Dr. Virgil P. Gibney, as professor of orthopedic surgery; Dr. Herman Von W. Schulte, as associate professor of anatomy, and Dr. Homer Fordyce Swift, as associate professor of medicine.

Dr. Edward Cameron Kirk, dean of the dental school of the University of Pennsylvania, and Drs. Matthew H. Cryer and Edwin T. Darby, of the faculty, have retired under the university age limit rule of 65 years.

We learn from the *Journal* of the American Medical Association that with the close of this term Italy loses from her teaching force, on account of the age limit, three well-known professors, C. Golgi, professor of general pathology and histology at the University of Pavia, who has contributed so much to our knowledge of the nerve cell; G. F. Novara, professor of clinical surgery at the University of Genoa, and G. Roster, professor of hygiene at the University of Florence.

Dr. Charles W. Pilgrim, president of the New York State Commission in lunacy, has been appointed superintendent and medical director of the Manhattan state hospital for the insane, to succeed the late Dr. Mabon, and Dr. Walter G. Ryan, medical inspector of the State Hospital Commission, has been appointed superintendent and medical director of the Hudson River State Hospital at Poughkeepsie.

The Canadian government has recently appointed Dr. C. Gordon Hewitt, F.R.S.C., to be consulting zoologist, in addition to his duties as Dominion entomologist and chief of the entomological branch of the Department of Agriculture. The duties of the office will be to advise in matters relating to the protection of birds and mammals and the treatment of noxious species.

D. W. Blakeslee, formerly assistant professor of electrical engineering at the University of Arkansas, and now engaged in industrial work, has received his commission as first lieutenant in the Engineer Section, Officers' Reserve Corps of the army.

Dr. Isaac F. Harris, formerly director of the Lederle Antitoxin Laboratories of New York and later director of the Arlington Research Laboratories of Yonkers, New York, has moved from Bronxville, N. Y., to New Brunswick, N. J., where he is head of the department of biochemistry in the research and biological laboratories of E. R. Squibb & Sons.

Professor Edwin Oakes Jordan, chairman of the department of hygiene and bacteriology at the University of Chicago, is at present engaged in investigations in Argentina.

Assistant Surgeon General Henry R. Carter, U. S. Public Health Service; Mr. Frederick L. Hoffman, statistician of the Prudential Life Insurance Company; Dr. Oscar Dowling, Shreveport, president of the state board of health, and Dr. William H. Seemann, New Orleans, state bacteriologist, began a tour of Louisiana on April 9, to make a survey of the malaria conditions. The survey will include thirty-five towns and cities and will be ended April 19.

Theodoor de Booy, of the Museum of the American Indian, Heye Foundation, has returned to New York after a six months' archeological survey of the Danish West Indies, now the American Virgin Islands. A large num-

ber of pre-Columbian specimens were excavated in aboriginal village sites and the results of these investigations showed that the Indian inhabitants of the Virgin Island group did not belong to the same race as the inhabitants of Porto Rico, as has always been thought. Skeletal remains of contemporary animals were found in the kitchen-middens and were of the greatest zoological interest, among the finds being the remains of a flightless bird hitherto unknown from this region.

AFTER spending a considerable time in Alaska as head of the John Wanamaker expedition of the University of Pennsylvania Museum, Louis Shortridge has sent a report of his acquisitions to the museum. Mr. Shortridge was formerly a chief of the Chilkat tribe of Indians of Alaska, and is familiar with their language and mode of life. He reports having acquired three sacred war helmets, said to be the last in Alaska, a large collection of dishes, baskets, tools, boxes and sacred bundles, used by the medicine men. All these will be on display at the museum.

DR. FREDERICK H. GETMAN lectured before the chemical department of the Johns Hopkins University on April 17 and 18, on "Allotrophy and the Metastability of the Metals."

PROFESSOR R. G. AITKEN, of the Lick Observatory, gave a lecture before the department of astronomy at Smith College on April 31, entitled "Unity of the Universe."

AT the bimonthly meeting of the Society of Sigma Xi, Duluth, held on April 17, Dr. E. L. Tuoby addressed the members on the subject "Why People Die." The usual dinner preceded the address.

PROFESSOR MADISON BENTLEY, of the University of Illinois, lectured before Wilson College, Chambersburg, on April 14. His subject was "Orientation in Man and Animals."

PROFESSOR ARTHUR GORDON WEBSTER, of Clark University, gave a lecture at Wellesley College last week on "Physics and War."

THE services of the late Dr. S. Weir Mitchell, for many years a member of the board of trustees of the University of Pennsylvania, distinguished as a man of science, a man of letters and physician, are to be commemorated by the placing of a memorial tablet in the reading room of the university library.

A SPECIAL memorial service in memory of the late Professor H. W. Conn was held at Wesleyan University on April 29. Dr. Shanklin presided and addresses were made by Professor C. E.-A. Winslow, of the Public Health Department of the Yale Medical School, who spoke on the work of Professor Conn for the welfare of the public and Professor W. N. Rice, who spoke of Professor Conn's thirty-three years' service to Wesleyan.

DR. EPHRAIM CUTTER, the microscopist and food expert, died on April 25, at West Falmouth, aged eighty-five years.

THE *Journal* of the American Medical Association announces the death of D. Vitali, formerly professor of pharmaceutic chemistry at the University of Bologna, aged eighty-five years; of L. Penix, professor of pharmaceutic chemistry and toxicology at the University of Bologna, aged fifty-five years, and of A. Corona, professor of experimental physiology at the University of Parma, aged sixty-five years.

WE learn from *Nature* that Dr. J. O. Hesse, director of the Associated Quinine Factories of Zimmer and Co., for many years the leading authority on the chemistry of quinine and other cinchona alkaloids, died at Feuerbach, near Stuttgart, on February 10, in his eighty-second year.

THE permanent secretary of the American Association for the Advancement of Science has sent us the following statement of the registration at the New York meeting: The actual registration was 2,136, including 103 members of the affiliated societies, according to the following geographical distribution: Alabama, 3; Arizona, 2; Arkansas, 2; California, 16; Colorado, 3; Connecticut, 73; Delaware, 6; District of Columbia, 156; Florida, 3; Georgia, 16; Idaho, 0; Illinois, 54; Indiana, 24; Iowa, 18; Kansas, 16; Kentucky, 3; Louisiana, 5; Maine, 17; Maryland, 77; Massachusetts, 240; Michigan, 36; Minne-

sota, 20; Mississippi, 2; Missouri, 21; Montana, 3; Nebraska, 3; Nevada, 1; New Hampshire, 16; New Jersey, 133; New Mexico, 0; New York (including 450 from New York City), 703; North Carolina, 19; North Dakota, 4; Ohio, 96; Oklahoma, 0; Oregon, 2; Pennsylvania, 170; Rhode Island, 15; South Carolina, 8; South Dakota, 2; Tennessee, 12; Texas, 15; Utah, 1; Vermont, 6; Virginia, 27; Washington, 1; West Virginia, 10; Wisconsin, 23; Wyoming, 5; Germany, 1; England, 1; France, 1; Canada, 35; Argentina, 2; Brazil, 1; Japan, 2; Switzerland, 2; Hawaii, 1.

The Earl of Derby, British secretary of state for war, in moving recently in the House of Lords the second reading of the bill to review military exemptions, stated that in the battle of the Somme alone over 400 doctors had been either killed or wounded, and that at the present time the army was, if not critically, at least lamentably, short of medical men.

According to the *Journal* of the American Medical Association the quota necessary to fill the present vacancies and requirements of the Army Medical Corps will be drawn from among those who graduated in 1912 to 1916. The total number that would be included in such a list would be approximately 19,000. The list of graduates in the five years mentioned, and also for 1917, is as follows:

MEDICAL COLLEGE GRADUATES

	From Colleges in Class			
	A	B	C	Totals
1912	2,790	1,063	629	4,482
1913	2,539	1,050	392	3,981
1914	2,626	686	282	3,594
1915	2,629	688	219	3,536
1916	2,630	695	193	3,518
1917[1]	2,641	625	101	3,367
Totals ..	15,855	4,807	1,816	22,478

As has been noted, there is an immediate need of additional physicians for the medical corps of the army, and for the medical corps of the navy. For these positions preference will be given to young physicians. The Army Medical Corps insists on a year's internship in a hospital after graduation; the Navy, however, is not now insisting on this, but is recognizing 1917 graduates.

[1] Seniors.

Research work in physics during the summer has of recent years grown to such proportions at Cornell that the physical laboratory is a busier place in June, July and August than during the term. To assist and encourage these workers, not by the offering of courses of instruction, but rather by occasional advice and council, arrangements have been made to have a member of the staff regularly in residence during this period who shall have no other duties. This work is entirely independent of the summer session. The arrangement is especially intended for former graduates who desire to return for a summer of investigation and for other working physicists. The member of staff in residence this summer will be Professor E. L. Nichols.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late John G. Johnson, one of the most noted lawyers in America, the University of Pennsylvania will ultimately receive a very large bequest; the exact amount can not now be stated, but it is estimated at from five to ten million dollars.

The Minnesota legislature which adjourned on April 19, appropriated for the University of Minnesota for the biennum 1917–19, a total of $3,735,500. This is an increase of $435,550 over the current appropriations. The sum made available for buildings and equipment is less than for 1915–17, but the maintenance funds have been increased by $225,000 per annum, or $450,000 for the biennum.

The University of Washington will have from the legislature and from other sources about eight hundred thousand dollars a year during the next two years.

Dr. Frederick C. Ferry, dean of Williams College, has been elected president of Hamilton College.

Dr. Alexander Petrunkevitch, assistant professor of zoology at Yale University, has

been elected full professor of zoology in the Scientific School.

THE following promotions have been made in the department of zoology at the University of California: Associate Professor S. J. Holmes to a professorship; Assistant Professors J. F. Daniel and Joseph Grinnell to associate professorships.

DR. GEORGE R. WELLS, associate professor of psychology in Oberlin College, has been appointed to a new professorship in psychology in the Ohio Wesleyan University, and will assume his duties in September. A psychological laboratory, housed in a separate building, has been provided and is being equipped at the latter institution.

M. P. MARIE, professor of pathologic anatomy at the University of Paris, has been appointed to the chair of diseases of the nervous system, to succeed the late Professor Dejerine. M. Letulle, hitherto professor of the history of medicine, has been given the chair of pathologic anatomy.

DISCUSSION AND CORRESPONDENCE

WANT OF ADAPTATION TO THE TIME OF THE PRINTING PRESS

IF the printing press is recognized as the most important instrument for the diffusion of knowledge, the advancement of science requires that it should be used with a precision like that shown in the use of the microscope or in the application of statistical methods.

It seems that this want of adaptation is shown in lack of adequate provision for, and in the common method of, the publication of scientific literature. Gifts to local establishments, in spite of their great value, seem silly compared with a proper endowment for the publication and distribution of scientific separates.

All scientific articles should be printed and sold separately, so that a student could subscribe for the literature of a certain subject. This would not prevent any one from binding together any papers he wished. Scientific publication is in a bad way, if it must be provided for by requiring one to pay for matter one does not need, and which, as far as one is concerned, is not worth shelf room. I am interested in literature relating to certain bees, but that does not incline me to pay for descriptions of Sarcophagidæ which take up eight pages for one species. In the library of the Missouri Botanical Garden I could not find papers by one author because the transactions in which they were printed did not contain enough botanical literature to justify purchase by that institution.

A magazine publishing transient articles is good enough, but one publishing important contributions to science in a various mixture is more or less of a burial place for such literature, whether one considers the persons the authors are trying to reach or those desiring to see the articles. That his writings should reach every one who is interested in them, or would profit by them, is as important for an author as it is for the student to see the writings in which he is interested—and the interests of both are in line with the advancement of science.

That the publishing of heterogeneous articles in journals is objectionable is shown by the practise of printing author's separates. But these are usually unsatisfactorily distributed and soon exhausted. The printing of separates operates against the interests of the journal when a writer avoids subscribing for it on the expectation of receiving the separates from their authors. For the sake of students a discriminative author may be inclined to publish all of his papers on a given subject in the same journal, but the journal may prefer a variety of papers in order to increase its subscription list. So, also, a paper which has some body to it is broken into monthly parts to make room for articles on different subjects. It is a question whether the magazines do not encourage fragmentary and desultory methods of investigation and publication.

On account of objection to too many, or too long, papers on the same subject, or simply inadequate provisions for publication, descriptions of American insects are often published in foreign journals—a practise clearly opposed to the interests of science. However, some au-

thors seem to have a mania for scattering literary fragments and may cultivate foreign journals merely for the sake of personal advertising.

Entomological News, 28: 141, after mentioning four journals which lasted an average of five years each, says:

> In general it seems that the number of specialists in any one or two orders of insects is not sufficient to support a special journal, and we know of none such provided with an endowment fund guaranteeing its permanency. In this matter we must still be entomologists, apparently, and yet the record of general entomological journals contains many a short-lived periodical.

The significant point here is that, while we are specialists as regards the literature we desire, we are general entomologists as regards the literature we have to pay for.

As educational institutions the university is local, while the printing press is cosmopolitan, the only cosmopolitan university. The publication of scientific literature should not be supported by requiring specialists to pay for literature they do not need, any more than the university should depend for its entire support upon the tuition of its students.

Charles Robertson

Carlinville, Illinois

FUNDAMENTAL CONCEPTIONS OF MODERN MATHEMATICS

To the Editor of Science: In your issue of August 4, there appeared a review of the first part of our "Fundamental Conceptions of Modern Mathematics," from the pen of Professor G. A. Miller. Against a hostile criticism, giving a portrayal of at least some of the main theses of our book and attempting to controvert them, we would have no inclination to protest. But all the important issues raised by our treatise are ignored by Professor Miller, who dwells upon features having no bearing upon any of the arguments of our work, or upon any of the doctrines which it is the purpose of the arguments to uphold.

Surely a reviewer can be justly expected to take up at least one or two of the principal doctrines of a treatise of which he disapproves, and show that these doctrines are erroneous. Our book contains an account of quantities and their classification; an investigation into what the symbols used by mathematicians really stand for. We set forth the classification of quantities into what we call sorts, kinds and varieties, and show the importance of this classification in the subdivision (originally conceived by De Morgan) of algebraic science into single algebra, double algebra, etc. A precise statement is given of what we apprehend to be the nature of the quantities dealt with in quaternions and other systems of vector analysis, and of their relation to the quantities of ordinary algebra. We attempt to show that any really scientific treatment of ordinary imaginary quantities must be based on vector analysis, all imaginary and complex abstract quantities (save those of zero value) being, in fact, relations between vectors. This is, we hold, the only way to ascend, from a blind use of imaginary and complex expressions without any clear apprehension of what they denote, to a rational comprehension of the matter; in other words, from mere computation, and manipulation of symbols, to true science. We show further that the mathematicians who look upon a variable as a quantity and those who regard it as a symbol are equally in the wrong; a variable being represented by a symbol and being composed of quantities. We consider the arrangement of the quantities of a variable, and show the importance of this commonly neglected attribute. We discuss the peculiar arrangements which must be at hand to justify the application of the theory of monogenic functions, and show the relation of these multiplex arrangements (as we call them) to the arrangements of the elements of the aggregates designated by Cantor as *mehrfach geordnet*. As the simplest of variables we put forward the ordinary progressions of elementary mathematics which are not usually recognized as variables at all. We attempt to show clearly just what distinctions should be drawn between a progression and a series; and, including all progressions and all series under the head of sequences, lay down the conditions under which a variable is to be

classified as a sequence. Passing to the question of functional relation we take up independent and dependent variables, and show that these names correspond to at least three separate distinctions, a fact not ordinarily recognized by mathematicians. We give a somewhat elaborate discussion of functional relations, showing that what is ordinarily put forward as the Dirichlet definition of function does not adequately characterize a functional relation, and moreover is not really the definition given by Dirichlet. We lay down what we deem to be the conditions under which two or more variables may be said to be in functional relation with each other; and show that previous authors, in their treatment of functions, have not attained to a clear and precise view of the essential characteristics of a functional relation.

To these salient features of our work Professor Miller gives no heed whatsoever, though assuredly they comprise topics of fundamental importance in mathematics. He is content to dismiss our inquiries by stigmatizing them as relating chiefly "to definitions and the choice of words." We plead that our work is concerned chiefly with the unfolding of the conceptions which words should awaken in our minds, and not with the words themselves. To purely verbal questions we give scant attention. In our endeavors to attain to distinct and exact conceptions of what is fundamental to the inquiries of mathematics, we have found that the portrayal of these conceptions, as set forth by mathematicians of the highest eminence, are not free from great imperfections. We have spared no labor in obtaining and in stating in full "the definitions given by those who have made important advances in the fields" into which we go; and when unable to assent to these definitions, we have carefully set down our reasons for holding that they do not truly depict the lineaments of the conceptions which they purport to unfold. And Professor Miller, though manifesting his disapproval of our criticisms, makes not the slightest attempt to show that our charges of error are baseless, and that Baire, Pringsheim, Riemann, Russell, Weber, and the other authorities whom we controvert are not guilty of the errors we ascribe to them.

Three passages of our work are specifically condemned by Professor Miller. All of these are trivial and could be removed from the work without affecting any of its doctrines or any major or minor argument put forward in defense of them. One fault that is imputed to us is that "on page 177 and elsewhere, the common erroneous assumption according to which the word function was used as synonymous with power is repeated." We merely say that "the word function *is said* to have been used by the older analysts as synonymous with power." We took care to insert the qualifying phrase *is said,* and so worded our remark is neither an assumption nor an error. And no reference to this usage occurs elsewhere. We are also rebuked for saying that "The only mathematician that we recall as making a specific distinction between quotient and ratio is Hamilton." We must acknowledge that such a distinction has been made by others, but we deny that the distinction we endeavor to enforce is as common as Professor Miller would have it appear. Finally we are chided for applying to imaginary and complex quantities the distinction between positives and negatives. Yet, if precedent is to be a guide, we can plead that both Gauss and Weierstrass used the two adjectives with respect to imaginary quantities.

ROBERT P. RICHARDSON,
EDWARD H. LANDIS

QUOTATIONS

SCIENTIFIC SNOBBERY

ONE reason for the neglect of science is that scientific men themselves frequently misrepresent the objects for which they work. For example, they often pretend that they perform their labors merely for their own amusement. We once heard it wittily said of such a man that he takes out his watch before dinner and exclaims, "Ha! I have half an hour before I must dress for dinner; I will just step over to my laboratory and make a discovery." But the public is not so easily deceived and therefore thinks in its dull way that the man of

science really labors in the hope of making some enormous fortune or obtaining some great honor. On another occasion, we heard it said of a man who has been toiling for years in the tropics for nothing, that "nobody knows why he does it, but we all believe that he wants a knighthood." When we timidly suggested that he was guided merely by a sense of duty, we were met by a stare of astonishment. Certainly this worker has never received a penny for his work as yet and never will, and we fear that not even a knighthood will come his way. No, men of science do not work either for amusement or to make fortunes. Like artists and musicians, they often find their labors fascinating because nature imbues them with an instinct in the directions chosen by them; but they are also conscious that their work will bring them no personal profit—not so much as that which a tithe of the ability shown by them in science would have yielded them in politics, law or grocery. Their ultimate object is to benefit humanity by adding to the store of knowledge which lifts the civilized man so far above the savage of the jungles. And that is the greatest object which any man can keep before his eyes.

Another form of scientific snobbery is the pretense that science has no practical object in view—it is so lofty a pursuit that the man of science should live among the stars and not soil his fingers with the common earth of everyday life. Even Lord Kelvin said "that no great law in natural philosophy has ever been discovered *for* its practical application" —though no one based more patents on his own researches than did Lord Kelvin. He may have been right in one sense, but certainly not in all (and he can not be accused of any form of snobbery). Thus geometry was really founded for the purposes of architecture and navigation. Mechanics was created to assist the engineer, and the theories of heat and of the conservation of energy were probably generated by the steam-engine; while the entire science of pathology has simply been created for its practical application as regards the prevention and cure of disease. Certainly investigations which were apparently useless at the outset have often led to valuable practical applications; but they were usually undertaken because the worker knew that he must first solve general problems before applying the solution to specific cases. We believe that all the great theorists had practical applications before them like a distant light even in the greatest darkness of their efforts. Is it likely that Newton, or Harvey, or Faraday did not prophetically see that their work would some day benefit humanity? Nature is infinite, and it is therefore wise to toil in immediate contact with human needs and not to lose oneself entirely far away from the remotest utilitarian objects. In most cases those who lose all touch of the useful in their investigations end by becoming useless themselves. They are above the practical, and therefore become unpractical, and finally impossible.

Perhaps the worst form of scientific snobbery is the pretense that the man of science is absolutely above cash in any form. Let us distinguish. To effect discovery, a man must concentrate all his energies upon a single point; he has no time to watch the share market, or to promote companies in connection with his findings; and it will be lucky if he succeeds in making any advance at all even with all his energies bent upon the point of issue. In that sense, therefore, he must ignore cash. But even here various circumstances should influence him. If he is a bachelor, he may do as he pleases, and may live as a recluse upon brown bread and water in a monk's cell if he wish. But if he has children or other dependants, is he justified in allowing them to be brought up uneducated in poverty? Such a thing would not be meritorious in him but a crime; for we have our duties not only to science but to our families. The scientist who pretends his indifference to money is, therefore, often only a snob. Moreover, although he himself may have no children, or may possess independent means, this need not necessarily be the case with others. His quixotic attitude merely lowers the price of science in the world and causes other and probably better men to suffer. Still further, for the most obvious economical reasons, it causes science

in general to suffer, because when young men see the poverty of the most successful investigators they hesitate to enter such fields of labor and the recruiting of the voluntary army of science is naturally reduced. Certainly no scientific man has the smallest desire to be a millionaire; but moderate competence is useful to him as to others. A certain amount of money gives him a proper influence for good in society, and enables him to devote himself to those investigations which his nature tells him he is most capable of conducting. On the other hand, keep him in poverty and he soon loses his enthusiasm; he becomes a fakir sitting in rags by the roadside, and the ripest years of his life are often wasted. Is there any intrinsic reason why the greatest efforts of the best minds in the most fertile of fields should lead to poverty? Yet the history of the world proves that they generally do so —to the loss not only of science but of the world. And why, pray? Because when science asks for her dole, the world replies, "But those great men, Smith and Jones, are proud to labor for nothing; why then should I pay you?" Alas, poor ignorant world does not know that if Smith and Jones are genuine workers they are probably too much engrossed in their toil to bestir themselves for payment; while if, as more often happens, they are merely purveyors of others' labors, then their lofty and popular pose is adopted for a purpose. And, indeed, snobbery is often a paying cult, and those who labor for nothing do little but frequently get much!

In science as in other things, the proper and honest procedure is to pay for work done; and, to be frank, the encouragement of science, of which we hear so much nowadays, must in the end come to this—or to nothing. And in science as in other things snobbery is a false pose which brings only contempt upon those who adopt it.—*Science Progress.*

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE third number of Volume 3 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The Condensation and Evaporation of Gas Molecules: Irving Langmuir, research laboratory, General Electric Company, Schenectady, N. Y. A discussion of the evaporation *vs.* the reflection theory with conclusions favoring the former.

The Ninth Satellite of Jupiter: Seth B. Nicholson, Mount Wilson Solar Observatory, Carnegie Institution of Washington. Comparison of the orbits of the Eighth and Ninth Satellites. The mean period of the Ninth is 745 days and its diameter is probably about 15 miles.

Aortic Cell Clusters in Vertebrate Embryos: H. E. Jordan, department of anatomy, University of Virginia. The hemogenic activity of embryonic endothelium is a normal function at a certain stage of embryonic development.

Rheotropism of Epinephelus Striatus Bloch: Hovey Jordan, Bermuda Biological Station for Research, Agar's Island, Bermuda. The lip region is the most sensitive part of the body surface. The end organs of tactile sensitivity serve also as organs of rheotropic sensitivity.

Studies of the Genus Phytophthora: J. Rosenbaum, Bureau of Plant Industry, Washington, D. C. A search for determining characters of diagnostic values in testing the different species.

A Possible Function of the Ions in the Electric Conductivity of Metals: Edwin H. Hall, Jefferson Physical Laboratory, Harvard University. A discussion of the number of ions necessary to maintain currents of great density, and of the temperature relations of conductivity if due to ions.

The Gravimetric Survey of the United States: William Bowie, Division of Geodesy, U. S. Coast and Geodetic Survey. A summary of the present status of the subject.

The Magnetization of Iron, Nickel, and Cobalt by Rotation and the Nature of the Magnetic Molecule: S. J. Barnett, department of physics, Ohio State University. A confirmation of the assumption that only electrons are in orbital revolution in all the substances investigated.

The Intensities of X-Rays of the L Series: David L. Webster and Harry Clark, Jefferson Physical Laboratory, Harvard University. A discussion of the intensities in the case of platinum as functions of the potentials producing them.

The Use of Vasectomized Male Mice as Indicators: C. C. Little, Harvard Medical School.

Photographic Magnitudes of Stars in the Selected Areas of Kapteyn: Frederick H. Seares, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Archaeology of Mammoth Cave and Vicinity: A Preliminary Report: N. C. Nelson, American Museum of Natural History, New York. Two isolated horizons of culture have been found; one indicating an agricultural people, the other a hunting people.

The Production in Dogs of a Pathological Condition which closely Resembles Human Pellagra: Russell H. Chittenden and Frank P. Underhill, Sheffield Laboratory of Physiological Chemistry, Yale University. The abnormal state is due to a deficiency in some essential dietary constituent or constituents presumably belonging to hitherto unrecognized but essential components of an adequate diet.

The Complete Enumeration of Triad Systems in 15 Elements: F. N. Cole, Louise D. Cummings and H. S. White. There are eighty types.

New Data on the Phosphorescence of Certain Sulphides: Edward L. Nichols, department of physics, Cornell University.

The Reactions of the Melanophores of the Horned Toad: Alfred C. Redfield, zoological laboratory of the Museum of Comparative Zoology, Harvard College.

The Coordination of the Melanophore Reactions of the Horned Toad: Alfred C. Redfield, zoological laboratory of the Museum of Comparative Zoology, Harvard College.

Petrified Coals and Their Bearing on the Problem of the Origin of Coals: Edward C. Jeffrey, botanical laboratory, Harvard University. Coals containing "coal balls" are abnormal, but there is no good evidence that "coal balls" are organized from material accumulated *in situ*.

The Effect of Degree of Injury, Level of Cut and Time within the Regenerative Cycle upon the Rate of Regeneration: Charles Zeleny, department of zoology, University of Illinois.

Preliminary Note on the Distribution of Stars with Respect to the Galactic Plane: Frederick H. Seares, Mount Wilson Solar Observatory, Carnegie Institution of Washington. A comparison of Mount Wilson counts with Kapteyn's, in which good agreement is found, as compared with both the results of Chapman and Melotte are not homogeneous.

National Research Council; Research Committees in Educational Institutions; Central Committees on Research; Reports of Meetings of the Executive Committee.

Edwin Bidwell Wilson

Massachusetts Institute of Technology, Cambridge, Mass.

SPECIAL ARTICLES

A QUANTITATIVE METHOD OF ASCERTAINING THE MECHANISM OF GROWTH AND OF INHIBITION OF GROWTH OF DORMANT BUDS[1]

1. Each plant possesses a number of dormant buds, which may grow out when they are isolated but which remain dormant under normal conditions. The problem to be solved is the mechanism of inhibition in the latter and of growth in the former case. Former results published by the writer on *Bryophyllum calycinum*[2] indicated that both phenomena are reciprocal, inasmuch as the growth of a bud depends upon the availability of certain material, while the inhibition is due in general to the non-availability of such material, and this non-availability is frequently brought about by the absorption or withdrawal of the material by another growing organ. Thus each node of *Bryophyllum calycinum* has two leaves and in the axil of each leaf is found

[1] From the Laboratories of The Rockefeller Institute for Medical Research, New York.

[2] Loeb, J., *Bot. Gaz.*, 1915, LX., 249; 1916, LXII., 293; 1917, LXIII., 25. "The Organism as a Whole," New York, 1916, p. 153.

a dormant bud. Besides, each of the numerous notches of a leaf contains a dormant bud. None of these buds grow out into shoots in the normal life of the plant. When we cut out a piece of the stem containing a node with its two buds, remove the two leaves, and suspend it in moist air, the buds of the stem will grow out very slowly if at all. If we isolate a leaf, and suspend it in moist air, a few of its many notches will grow out into shoots. When we suspend a piece of stem with one node and with only one leaf attached in moist air the bud on the stem opposite the leaf will grow out very rapidly, but the growth of shoots in the leaf will be suppressed or very much retarded. The writer assumed that in this case substances needed for the growth of the buds in the leaf were absorbed by the stem and used for the growth of its bud; and that as a consequence the buds in the leaf were prevented from growing owing to lack of material. The writer has recently carried out a series of quantitative experiments which seem to make this theory fairly certain and a few of which shall be described in this preliminary note.

2. According to this theory, leaves of *Bryophyllum* of equal size should when isolated produce in the same time, at the same temperature and moisture, the same mass of shoots from their notches. This is only generally true when we compare leaves of different plants or of different age of the same plant. If, however, we compare the two leaves belonging to the same node of a plant (having the same size, age and history) the weight of the shoots produced by the two leaves is equal within the unavoidable limits of error of such an experiment, as the examples in Table I. show. The two leaves of a node will always be designated as *a* and *b*.

Leaves of Bryophyllum calycinum of equal size (and from the same node) produce in the same time, under identical conditions, equal masses of young shoots (although the number of shoots formed is generally different in the two leaves).

3. It followed, moreover, that if we diminish the mass of a leaf by cutting out a piece from its center while the sister leaf (from the same node) remains intact, the shoots produced by the two leaves (when isolated from the stem) should be in the ratio of the masses of the two leaves. In five leaves the center was cut out while their sister leaves were left intact. Both sets of leaves were supended in an aquarium with their apices in water. After 37 days the weight of the shoots formed in each set of leaves as well as the weight of the leaves was ascertained and it was found that each set of leaves produced shoots in proportion to its mass (Table II.).

TABLE I

Number of Experiment		Number of Shoots Produced from Leaf	Weight of Shoots Produced in 33 Days Gm.
I.	*a*	3	0.350
	b	3	0.345
II.	*a*	1	0.290
	b	2	0.306
III.	*a*	2	0.375
	b	4	0.385
IV.	*a*	5	0.594
	b	4	0.607
V.	*a*	4	0.457
	b	5	0.455

TABLE II

Leaves Dipping in Water

	Total Weight of 5 Leaves, Gm.	Total Number of Shoots Produced	Total Weight of Shoots Produced, Gm.	Weight of Shoots Produced per Gram of Leaf in 37 Days, Mg.
Center of leaf cut out..	7.61	11	0.755	99
Leaves intact	13.80	9	1.405	101

The shoot production in the two sets of leaves was, therefore, within the limits of error in proportion to the mass of the leaves themselves.[3]

When the same experiment is made with leaves not dipping in water the results are not so perfect, due possibly to the fact that the leaves with their center cut out dry out more rapidly than the intact leaves (Table III.).

[3] Since the surface of the leaves is approximately proportional to the mass, we must for the present reserve the privilege of substituting the surface for weight in the expression of the numerical relation, if necessary.

TABLE III

Leaves Kept in Moist Air

	Total Weight of 5 Leaves, Gm.	Total Number of Shoots Produced	Total Weight of Shoots Produced, Gm.	Weight of Shoots Produced per Gram of Leaf in 38 Days Mg.
Center of leaf cut out..	5.42	13	0.690	109
Leaves intact	11.81	20	1.207	102

These observations agree with the assumption that the growth of dormant buds is determined by and is in proportion to the quantity of a certain material available for the buds.

4. In the previous publications attention had been called to the fact that in an isolated leaf only a few of the numerous notches grow into shoots and this had been explained on the assumption that those notches which happen to grow out first attract all the material from the leaf and thereby prevent the other notches from growing. This suggestion was supported by the observation that if a leaf is cut into isolated pieces each possessing one notch, each notch gives rise to a new shoot (provided that the piece is not too small). The shoots in the subdivided leaf grow more slowly than the less numerous shoots of whole leaves. On the basis of our quantitative method we should therefore expect that if of two isolated sister leaves one (*a*) is left intact while the other (*b*) is cut into as many pieces as it contains notches, the ratio of the weight of shoots produced to the weight of the leaf should be equal in both leaves; in spite of the enormous difference in the number of shoots produced. If a leaf is divided into two halves *a* and *b*, and half *b* further subdivided into as many pieces as there are notches, the numerous shoots produced by the isolated notches should not weigh more than the few produced in the intact half.

These experiments encounter the difficulty that if the piece of a leaf is below a certain size its notch will fail to produce a shoot; and if the piece approaches this lower limit its shoot production is still considerably retarded so that the law of proportionality no longer holds. In spite of this and some other sources of error the results are in fair agreement with the theory.

TABLE IV

Number of Experiment		Weight of Leaf, Gm.	Number of Shoots Produced	Total Weight of Shoots Produced in 33 Days, Gm.	Weight of Shoots Produced Per Gram of Leaf Mg.
I.	*a* (intact leaf).....	4.47	2	0.450	100
	b (subdivided leaf).....	3.17	15	0.300	95
II.	*a* (intact leaf).....	1.866	3	0.316	169
	b (subdivided leaf)	1.727	14	0.345	200
	Half leaves			Total Weight of Shoots Produced in 21 Days	
III.	*a* (intact half of leaf).....	1.800	1	0.072	39
	b (subdivided half of leaf)...	1.586	6	0.049	31
IV.	*a* (intact half of leaf).....	1.062	3	0.063	59
	b (subdivided half of leaf)...	0.920	6	0.057	62

The experiments support the view that when in a leaf shoots are formed they withdraw material from the other notches and that it is this withdrawal of material which prevents the other notches from growing.

5. By the same reasoning we should expect that the inhibition in the growth of the notches of the leaf by a piece of stem (referred to in the beginning of this note) is due to the absorption of material from the leaf by the stem. In corroboration of this assumption the writer has been able to show that the inhibiting effect of the stem upon leaves of the same size increases with the mass of the stem. It has also been possible to show by quantitative experiments that the inhibiting effect of pieces of stem of the same size upon leaves of different size diminishes when the size of the leaves increases. We may say that the stem acts upon the leaf as if it reduced the size of the latter.

But the withdrawal of material by another organ is not the only way by which the growth of a bud is inhibited. The main condition for growth is that the material reaching the bud

should exceed a certain limiting quantity. If there is not enough material available or if for anatomical reasons the material can not reach a bud the latter will be prevented from growing.

6. We do not wish to discuss the nature of the substances which cause the growth, but it is important to know that the leaves will form no shoots or only very few if kept in the dark. Six pairs of leaves from the same node were suspended in moist air, one leaf of each node in the dark, one in the light. After one month the six leaves in the dark (weighing 11.65 gm.) had produced only 3 etiolized shoots weighing 0.016 gm., while the six sister leaves in the light (weighing 8.03 gm.) had produced 24 normal shoots, weighing 0.544 gm. The shoot production in the light was therefore more than thirty times as great as that in the dark. This may mean that the material from which the new shoots are produced in a leaf is itself to a large extent a product of or dependent upon the assimilatory activity of the leaf. The root formation did not seem diminished in the dark, and at first it seemed even enhanced.

JACQUES LOEB

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE 117th regular meeting of the Botanical Society of Washington was held in the assembly hall of the Cosmos Club, at 8 P.M., January 2, 1917, President T. H. Kearney presiding.

The program was devoted to the subject of Plant Introduction, under which the following papers were presented:

The Need of More Foreign Agricultural Exploration (illustrated): DR. DAVID FAIRCHILD.

Dr. Fairchild called attention to the need of more foreign exploration and to the fact that up to the present time a comparatively small amount of money had been expended on this important work. The most successful type of agricultural exploration is that carried on by men interested in particular crops. The need of studying the methods of agricultural production in foreign countries, some of the more important recent introductions, and the difficulty in getting people to adopt new foods were emphasized.

The Wild Relatives of Our Crop Plants; Their Value in Breeding; How to Secure Them (illustrated): MR. WALTER T. SWINGLE.

The usefulness of the wild relatives of our crop plants in securing such desirable qualities as hardiness, earliness or lateness of blooming or of ripening, disease resistance, extra vigor, etc., were pointed out. As an example, the desert kumquat of Australia, which does not resemble closely in general appearance true Citrus, was found to be a most desirable plant for the successful breeding of hardy and drought-resistant citrous fruits. Mr. Swingle stated that a properly digested technical knowledge of the wild relatives of our cultivated plants is an indispensable foundation for all efficient plant introduction and plant breeding.

The Introduction of Foreign Plant Diseases: MR. R. KENT BEATTIE.

Mr. Beattie separated all diseases of economic plants into two groups: (1) Those which have passed from native plants to the introduced hosts; (2) those which have been introduced, such as citrus canker and chestnut-bark disease. Diseases are brought in on diseased crop plants introduced for commercial use or for scientific purposes, or the spores may be carried in on plants not affected by the disease. Commercial-plant introductions are inspected usually by entomologists and fungus diseases are often not detected. The material imported by the U. S. Department of Agriculture undergoes rigid inspection and retention in case any diseases are suspected. During the year 1916 the Federal Horticultural Board found on the material imported by the U. S. Department of Agriculture 157 different diseases.

The Protection and Propagation of Plant Introductions: DR. B. T. GALLOWAY.

Dr. Galloway called attention to the rapid change in public sentiment in the matters of plant sanitation and hygiene and to the need of a constructive policy in adequately protecting our crop plants, and at the same time not closing the doors to the development of new crop industries. He also discussed a number of the problems confronting the Office of Seed Plant Introduction.

THE 118th regular meeting of the Botanical Society of Washington was held in the assembly hall of the Cosmos Club, at 8 P.M., February 6, 1917. Forty-four members and fourteen guests were present.

Dr. B. T. Galloway, Mr. Charles F. Deering and Professor W. D. Crocker were elected to membership.

The program of the evening was devoted to the subject of "The Relation of Plant Succession to Forestry and Grazing."

Mr. C. G. Bates discussed the natural regeneration of forest stands in the climax formations of the Rocky Mountain region and called attention especially to the temporary control of the subclimax following such a disturbance as cutting. In practical management of forests the distinct problems in kind and degree of cutting can be met by the application of an intimate knowledge of the range of conditions under which succession takes place.

Two types of succession in the forests of Oregon and Washington were described by Dr. J. V. Hoffman. The first type is dependent upon the production of seed by remaining seed trees. This type advances into an unoccupied area at the rate of 150 to 300 feet during each generation, and the resulting forest is composed of trees of unequal age. In the second type the seeds produced by the old stand retain their viability when the forest is destroyed and germinate to form a new forest of the same type and of even-aged trees.

Mr. A. W. Sampson called attention to the importance of studies of succession in the management of range lands of the Forest Service. Certain species appear early and others late in the succession which leads to the development of the climax or ultimate type. From the record of the time of appearance or disappearance of these species it is possible to determine whether the pasture is being properly or improperly used. In the latter case changes in the management can be initiated which will retain or favor the reestablishment of desirable plants.

The revegetation of badly over-grazed areas in the Santa Rita Mountain district of Arizona was discussed by Mr. E. O. Wooton. When such areas were protected small weedy annuals and annual grasses were first to enter, followed by short-lived perennial grasses, and these in turn by long-lived perennial grasses and a few species of perennial herbs and low undershrub. Fire was found to be the principal factor in preventing shrubs from replacing the grasses.

The papers were discussed by Mr. G. A. Pearson, Mr. J. T. Jardine, Dr. David Griffiths, and Dr. H. L. Shantz.

H. L. Shantz,
Corresponding Secretary

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 509th meeting of the society was held in the lecture room of the Carnegie Library on March 19. At this meeting Dr. Fay-Cooper Cole, of the department of anthropology, Field Museum of Natural History in Chicago, delivered a lecture on "The Pagan Tribes of the Philippines."

Dr. Cole first described the peopling of the islands, and the intermingling of peoples which has resulted in the present population. The pigmy blacks or Negritos were held to be the aboriginal inhabitants of the islands. The invading peoples are believed to have come in several waves, the earliest of which appears to have been composed of a people who were physically allied to the Polynesians. These were followed by successive invasions of primitive Malays. The effects of movements of alien peoples and beliefs was also outlined. Traces of the Hindu-Buddhist movement are evident in the folk-lore, while the great effects of the introduction of Mohammedism and Christianity are a matter of historic record.

The greater part of the evening was devoted to a description of the most fundamental facts of the religious, social and economic life of three pagan tribes—the Bagobo of southern Mindanao and the Bontoc Igorot and the Tinguian of northern Luzon. The Bagobo live on the lower slopes of Mt. Apo, in whose lofty summit a host of spirits are supposed to dwell. The people also believe in a class of powerful spirits which inhabit the realms of the earth. The Igorot and Tinguian, living in a rugged country, have terraced the mountain sides for the cultivation of rice, and have developed an elaborate system of irrigation. Until recent years both the last-named tribes have been ardent head-hunters, but the motive for taking the skull, as well as its final disposition, differ in the two districts. These tribes resemble each other in language and physical type but differ in political organization and in the construction of dwellings.

Frances Densmore,
Secretary

Errata: In making up the article on the Industrial Fellowships of the Mellon Institute, by Dr. R. F. Bacon, published in the issue for April 27, pp. 399 to 403, two errors occurred. The footnote on p. 402 should read: "The system of industrial research founded by the late Dr. Robert Kennedy Duncan was initiated at the University of Kansas, and later transferred to the University of Pittsburgh." The name of William A. Hamor, M.A., assistant director, should have been included among the officers of administration.